# Data Reprocessing on Worldwide Distributed Systems

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for the DØ Collaboration
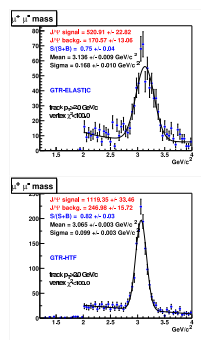
CHEP'04, Interlaken, Switzerland

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## Introduction

### Improved understanding of the DØ-Detector

- DØ tracking improved significantly during 2003
- Basis:
  - improved understanding of the DØ-Detector
  - based on reality rather than design/plans
- $100\,\text{pb}^{-1}$ (60%) of the data were reconstructed with older software versions

$\Longrightarrow$ *Redo reconstruction of data*

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## Rereconstruction

### The tasks from the computing perspective

- $100\,\text{pb}^{-1}$ correspond to ca. 300M events.
- RAW data 250kB/Event $\Longrightarrow$ 75 TB.
- DST output 150kB/Event $\Longrightarrow$ 45 TB.
- 50s/Event on 1GHz PIII CPUs
  $\Longrightarrow$ 2000CPUs for completion within 3 Months.
- Central Farm (1000CPUs) used to capacity with data taking.
- Shutdown of 8 weeks sufficient to do 30%.

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## Available Resources

| FNAL Farm, | 1000CPUs | DØ installed |
|---|---|---|
| GridKa, | 300CPUs | DØ installed |
| Lyon, | 220CPUs | DØ installed |
| Nikhef, | 80CPUs | in EDG |
|  | 320CPUs | in EDG |
| SAR, | 130CPUs | DØ installed |
| UK, | 340CPUs | DØ installed |
| Westgrid, | 300CPUs | DØ installed, from Oct. |
| External | 1690CPUs | (1GHz PIII equiv.) |

$\Rightarrow$ capacity more than doubled.

**But:** Each cluster is different; even „DØ installed" can be very different.

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## Application flow of a rereconstruction job

| Raw Data File | DST-File | (several 100/run) |

*Database*

d0reco

DST File (150kB/Event) plus Metadata
+
TMB File (20kB/Event) plus Metadata
+
Consistency and completeness tests

- Several TMB files shall be merged before storing.
  $\Rightarrow$ Creates more complicated workflow
- Database access from Europe *much* to slow
  $\Rightarrow$ old DSTs as input.

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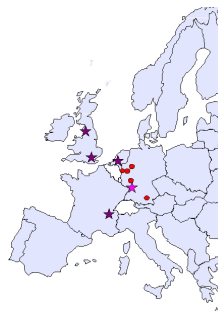
## Management of Large Batches of Jobs

### Problem
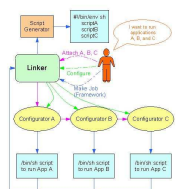Initialisation, local paths for intermediate and final results, copy mechanisms are different on different clusters:
person power intensive.

### Base of improvements
Automate linking for several programs into a single job based on a job description and local configurations.

### Workflow management: `Runjob`
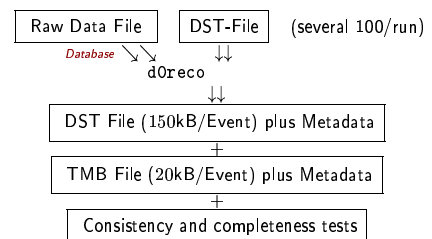- handles chains of executables
- passes output of one program as input to a following
- track metadata
- separates calling details from organisation
- allows for automatic parallelisation of jobs

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## Distribution of Input Data

### Sequential Access through Metadata: **SAM**

The order of events in a dataset has no meaning.

### Optimisation
- Don't loop through file lists.
- Request datasets.
- Order in which files corresponding to a dataset are processed may change.
- System optimises the order to minimise tape access and tape mounts or WAN transport.
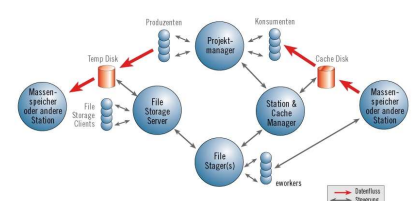
### WAN Transport

`sam_cp` as generic interface to GridFTP, bbftp, tape access . . .

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[1] M. Diesburg and D. Wicke, DØ Reprocessing (Project Web Page)
http://www-d0.fnal.gov/computing/reprocessing/

[2] K. Riesselmann, Ferminews 27, 2 (Feb. 2004) 2.
http://www.fnal.gov/pub/ferminews/ferminews04-02-01/p1.html

[3] D. Wicke, IJMPA, Proceedings to DPF 2004, Riverside, CA (in preparation).

[4] K. Riesselmann, Cern Courier 44, 7 (Sep. 2004) 16.
http://www.cerncourier.com/main/article/44/7/15

## Backflow of Results

### TMBs

- Merging of TMBs only possible at FNAL.
- Individual TMBs shouldn't be stored in SAM .
- Backflow "manually" using sam_cp.
  - TMBs and Metadata.
  - Logfiles and results of crosschecks.

### DSTs

- Storage initially not foreseen.
- Later: Remote storing into SAM onto decentral locations.
- Transport to user on first access.

## Distribution of Jobs

### Manually

- Problematic datasets were reconstructed from RAW at FNAL.
- Datasets provided in sizes requested by each site.
- Reconstruction of these datasets started remotely
  ⇒ Individual solutions for administrating jobs.
  ⇒ Individual solutions for error recovery.

### Per GRID

- Within the 3 British sites distribution of jobs done via SAMGrid/JIM.
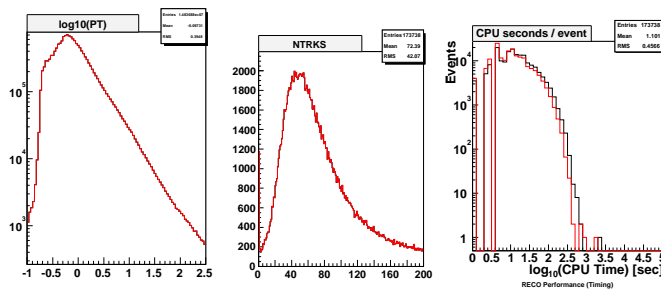- Nikhef tried to use EDG (basis of LCG) to distribute jobs to further sites.

JIM

## Certification of Sites

- Each centre was required to certify, i.e. process a defined dataset of 66 files.
- Results were compared to a reference
  (which itself was certified by comparing to processing from RAW):

## Rereconstruction, Problems

### Organisation

- Late release of d0reco
  ⇒ Implicit dependencies on the (FNAL) environment noticed late.
  ⇒ Incorrect planning, wrong priorities, unnecessary developments.
  ⇒ Significant additional delay.
- The flexibility makes planning very difficult.

### Data distribution

- Delays occured due to other applications with high number of tape access
- Bottelneck in central file router of SAM.
- Network bottlenecks on the way to some centres.

## Job Running

- A large number of jobs crashed (up to 20%).
- Lots of manual intervention.
- Bookkeeping is important.

## Data backflow

- Significant number $\mathcal{O}(1/1000)$ of corrupted TMBs after copying back
- GridFTP doesn't check this sufficiently well.

## Summary and Outlook

- First data rereconstruction on globally distributed clusters
  - 300M Events or 45TB of data were processed at 7 centres.
  - 30% or 15TB of these at systems remote of Fermilab.
  - Grid-concepts for data and job distribution were used.

- *The concepts foreseen for LHC proven in general.*

- Next distributed Data rereconstruction at DØ planned for this year
  - including external merging, i.e. complete external production.
  - from raw data, i.e. with database access.
  - using SamGrid/JIM and LCG.